International Journal of Civil Engineering and Technology (IJCIET)
Volume 8, Issue 3, March 2017, pp. 1077–1084 Article ID: IJCIET_08_03_110
Available online at http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=3
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

EXPERIMENTAL INVESTIGATION ON FLEXURAL BEHAVIOR OF HYBRID FIBER REINFORCED CONCRETE BEAM

K. Tamilselvan
Research Scholar, Department of Civil Engineering, Karpagam University, Coimbatore, Tamilnadu, India

Dr. N. Balasundaram
Professor/HOD, Department of Civil Engineering, Karpagam University, Coimbatore, Tamilnadu, India

ABSTRACT

The aim of this experimental investigation is to study the flexural behavior of Hybrid fiber reinforced concrete beams (HFRC). In this study, by adding the fibers in normal concrete adequate ductility of concrete is ensured and shrinkage crack is reduced. The behavior of RC beam structures strengthened by using hybrid fiber reinforced (HFRC) is analyzed. Grade of M30 as per IS 10262:2009 concrete beams are casted. The steel and Polypropylene (PP) fibers are used in different proportions with 0.5% of volume of concrete. The properties of the fresh concrete (workability) is obtained from the Slump test, Compaction factor Test and the hardened concrete were done by Compressive strength, Split tensile strength and Flexural strength by adding Super plasticizer CONPLAST SP 430 at 0.8% to the total volume. The hybrid fibers various proportions are 33:67, 50:50 and 67:33 for the volume fraction is 0.5% of volume of concrete were used in the concrete mixes. Totally six beams were casted including control beam specimen. The test results show the use of Hybrid Fiber reinforced concrete improves flexural behavior of the beams during loading conditions.

Key words: Fiber Dosage, Flexural strength, Polypropylene fiber, Steel Fiber, Super plasticize.

Cite this Article: K. Tamilselvan and Dr. N. Balasundaram, Experimental Investigation on Flexural Behavior of Hybrid Fiber Reinforced Concrete Beam. *International Journal of Civil Engineering and Technology*, 8(3), 2017, pp. 1077–1084.
http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=3

1. INTRODUCTION

Concrete is a very important and widely used material in Construction. It is strong under compression, long life and economical. To avoid such weakness over concrete material fiber reinforced concrete were used alternatively. To increase the strength of the material, numerous studies on fiber reinforced concrete have been performed. Addition of randomly distributed fibers (steel, synthetic) drastically improves the performance of concrete and gives very high compressive strength, high tensile strength, high elasticity modulus ,ductile behaviour ,high durability , low shrinkage cracking etc., depends also on the fiber type, size, aspect ratio and volume fractions used to reinforce. The use of these fibers has increased tremendously in construction of structures because addition of fibers in concrete improves the toughness, flexural strength, tensile strength and impact strength. In this investigation explains the flexural behavior of RC beams, strength, and failure mode of combinations of two fibers reinforced RC beams.

2. EXPERIMENTAL PROGRAM

2.1. Materials used

2.1.1. Cement

The Ordinary Portland Cement Grade 53 was used as per codal Instructions.

2.1.2. Fine Aggregate

The river sand free from impurities was used. This size of it is less than 4.75mm. The specific gravity and finess modulus were found to be 2.65 and 2.25 respectively. The passing percentage is within the limits as per IS 383-1970.

2.1.3. Coarse Aggregate

The Coarse aggregate is passing under 20mm and retained in 12.5mm sieve. It having specific gravity 2.56 is used. The finess modulus of coarse aggregate was found to be 2.90. The passing percentage is within the limits as per IS 383-1970 [4].

2.1.4. Water

Casting and curing of specimens were done with the portable water.

2.1.5. Super Plasticizer

Superplasticizers also known as High Range Water n Reducers are used for its properties which help in improving flow characteristics or suspensions, avoid particle segregation and more. Super Plasticizers (IS 9103 – 1999) are used where a high degree of workability and its retention are required.

2.1.5.1. Advantage of Water Reducing Admixture

Adding them to concrete or mortar allows the reduction of water to cement ratio, not affecting the workability of the mixture and compressive strength can be obtained more. Adding admixture, Lower cement content also obtained workability and compressive strength will be same. In this investigation, Super plasticizer CONPLAST SP 430, based on Sulfhanated naphthalene polymers, complies with IS 9103-1999 and ASTMC-494 were used.

2.1.5.2. Physical & Chemical Properties of Superplasticizer

Color	: Brown
Specific Gravity	: 1.22 to 1.225
Chloride Content	: Nil
Solid Contents	: 40%

Figure 1 Super Plasticizer

2.1.6. Steel Fiber

Figure 2 Steel Fiber

2.1.6.1. Physical properties of Steel Fiber

Table 1 Steel Fiber Properties

SPECIFICATION	VALUES
Length in mm	55
Diameter in mm	1.0
Aspect ratio	55
Tensile strength in GPa	1.71
Elasticity modulus in GPa	205
Specific gravity	7.48

2.1.7. Polypropylene Fiber

It can control the plastic shrinkage cracks, because it has been good ductility, fineness, and dispersion. By the proper mixing of the fibers, Better mechanical properties of concrete can be The diameter of monofilament fibers is elastic modulus is 5.88 GPa, and the tensile strength is 320 MPa.

Figure 3 Polypropylene Fiber (PP)

2.1.7.1. Physical properties of Polypropylene fiber (PP)

Table 2 Properties of PP Fiber

SPECIFICATION	VALUES
Length in mm	40
Diameter in mm	1
Aspect ratio	40
Specific gravity(g/cm^3)	0.9

3. MIX PROPORTIONS

3.1. Design Mix Grade – M30

The design mix can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. IS 10262:2009 Mix Design is adopted for Proportioning of Concrete Mix M30.

The IS 10262:2009, presents guidelines for mix design. Mix proportioning details are tabulated.

3.1.1. Proportioning of Stipulations

Grade designation : M30
Trade of cement : 53 grade OPC
Max nominal size of aggregate : 20mm
Minimum cement content : 320kg/m^3
Maximum water cement ratio : 0.4

Workability : Slump 100mm
Exposure condition : Mild as per IS456:2000
Method of placing : Hand placed concrete
Chemical admixture : Super plasticizer

4. PREPARATION OF SPECIMEN AND CURING

Casting of the beam specimen is six in control mix and the combination of hybrid fiber reinforced concrete. The optimization of the mechanical properties is found out from the literatures study. The design of concrete was made upon by the IS code for control and HFRC mixes. The reinforcement details were go through as per codal provisions.

The fiber content added in the concrete is dependent upon the volume of concrete. The optimum found out for steel fiber is 0.5%, by keeping this as standard and PP fibers are added hybrid with 0.5% of steel fiber as 33%-67%, 50%-50% and 67%-33% respectively. Steel moulds were used for moulding the concrete as the absorbtion of water is lower than the other seasoned wood.

Compaction of concrete is done properly throughout the beam. After casting the beams it was demoulded next day and it was put into portable water for 28 days.

5. TESTING

The beams to be tested are placed in the loading frame of capacity 5000kN under three point loading. The end condition of the beam is to be kept as simply supported. The beam is to be divided into number of grids before placing in the loading frame for the observation of crack pattern. For finding the deflections under the one-third loading points and centre, the deflectometers are to be placed in the beam to measure the mid-deflection.

6. COMPRESSIVE STRENGTH ON CONCRETE CUBES

Table 3 Compressive Strength on cubes

Sl. No.	Specimens	% of Fiber dosage	No. of Specimens	Mean value of Compressive strength, N/mm^2
				28 days
1.	CB	-	3	31.87
2.	FRC^1	ST0.5	3	38.52
3.	FRC^2	PP0.5	3	30.95
4.	HFRC^1	ST0.17PP0.33	3	32.50
5.	HFRC^2	ST0.25PP0.25	3	38.52
6.	HFRC^3	ST0.33PP0.17	3	42.10

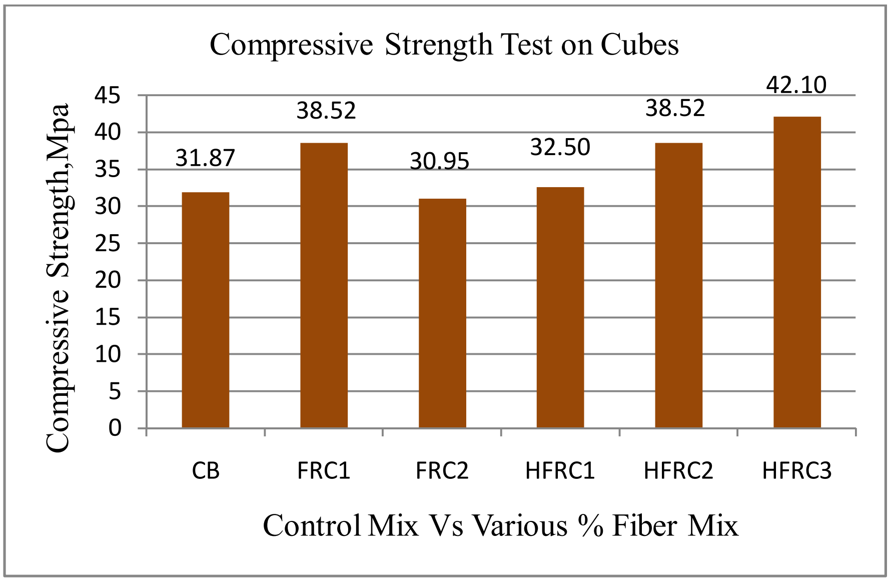

Figure 4 Compressive Strength Test on Cubes at 28 days

7. SPLIT TENSILE STRENGTH ON CONCRETE CYLINDERS

Table 4 Split Tensile strength on cylinders

Sl. No.	Specimens	% of Fiber dosage	No. of Specimens	Mean value of Split Tensile strength, N/mm^2
				28 days
1.	CB	-	3	3.90
2.	FRC[1]	ST0.5	3	4.30
3.	FRC[2]	PP0.5	3	4.15
4.	HFRC[1]	ST0.17PP0.33	3	4.20
5.	HFRC[2]	ST0.25PP0.25	3	4.40
6.	HFRC[3]	ST0.33PP0.17	3	4.60

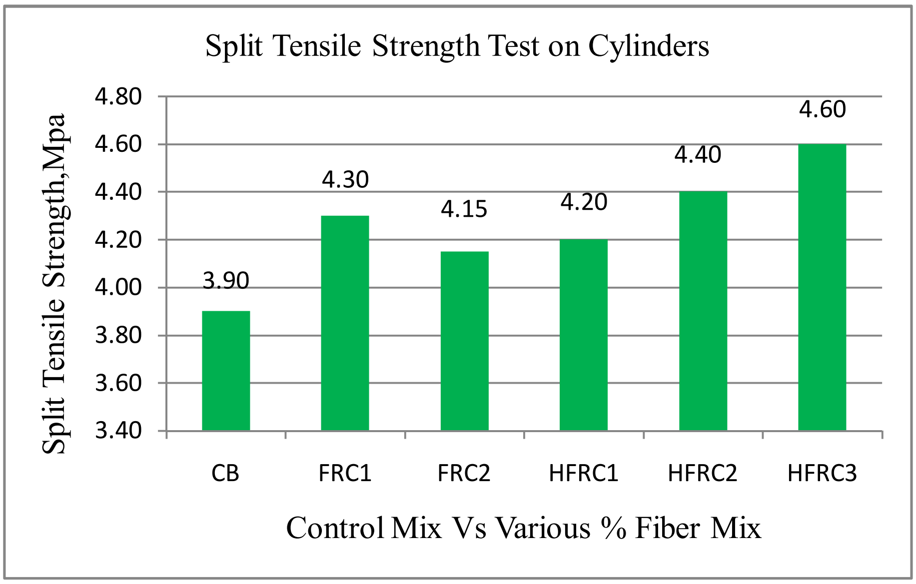

Figure 5 Split tensile Strength Test on Cylinders at 28 days

8. FLEXURAL STRENGTH ON CONCRETE BEAMS

Table 5 Flexural strength on beams

Sl. No.	Specimens	% of Fiber dosage	No. of Specimens	Mean value of Flexural Tensile strength, N/mm^2 28 days
1.	CB	-	3	4.30
2.	FRC^1	ST0.5	3	5.12
3.	FRC^2	PP0.5	3	4.62
4.	HFRC^1	ST0.17PP0.33	3	5.30
5.	HFRC^2	ST0.25PP0.25	3	5.52
6.	HFRC^3	ST0.33PP0.17	3	5.80

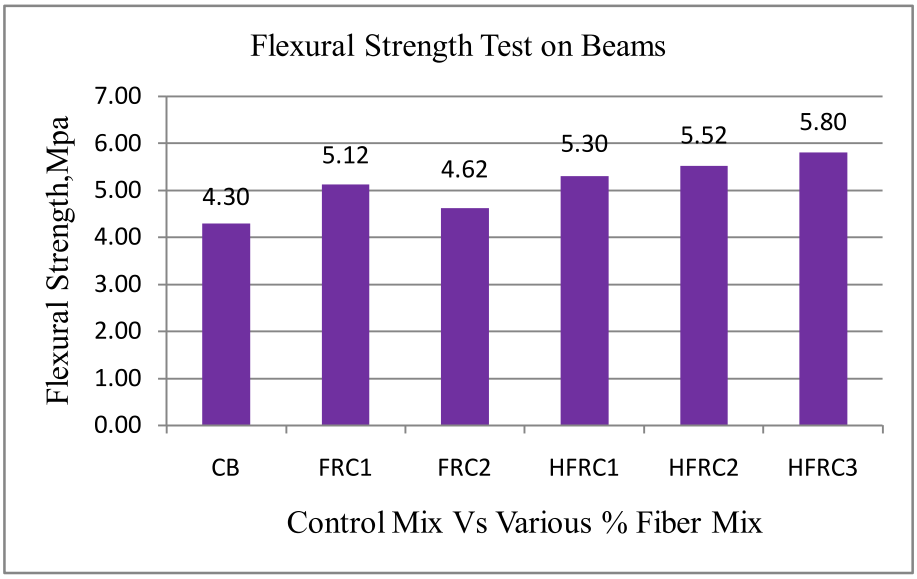

Figure 6 Flexural Strength test on Beams at 28 days

9. CONCLUSION

The results from the hardened concrete were concluded below.

- The hybrid fiber reinforced concretes compressive strength containing ST0.33PP0.17 for the volume fraction 0.5% is 12-15% higher than the FRC.
- The hybrid fiber reinforced concretes flexural strength containing of ST0.33PP0.17 for the volume fraction 0.5% is 25-35% higher than the FRC.
- The hybrid fiber reinforced concretes split tensile strength containing of ST0.33PP0.17 for the volume fraction 0.5% is 22-30% higher than the FRC.
- ST-FRC is giving optimum strength while comparing with PP-FRC. The Mechanical Properties of those fibers were varies from 3-5%.
- If the content of steel fiber increase the optimum value of mechanical properties also increase with PP fiber, PP is also having good strengthening while compare with Steel.
- The final result concluded is that by adding of hybrid fibers increase the mechanical properties of concrete than the fiber concrete.

REFERENCES

[1] A. Sivakumar, Manu santhanam, "Mechanical properties of high strength concrete reinforced with metallic and non-metallic fibers".

[2] C. Albano, N. Camacho, M. Hernandez, A. Matheus, and A.Gutierrez, 'Influence of content and particle size of waste pet bottles on concrete behavior at different w/c ratios'.

[3] BIS: 383-1970 (reaffirmed 1997), 'Specification for Coarse and Fine Aggregates from Natural Source for Concrete', New Delhi.

[4] A.Ravichandran, K. Suguna, P.N. Ragunath, D. Govindarajulu, 'Performances of High-strength concrete beams with Hybrid Fiber Reinforcements'.

[5] BIS: 12269-1987 (reaffirmed 1999), 'Specification for Ordinary Portland Cement'.

[6] S. Eswari, P. N.Raghunath and K.Suguna, 'Regression Modeling for Hybrid Fiber Reinforced Concrete'.

[7] R. Sakthivel and Dr. N.Balasundaram (Mar-Apr 2016) "Experimental Investigation on Behaviour of Nano Concrete" International Journal of Civil Engineering and Technology, Vol.7, Issue2,pp-315-320.

[8] Mr. S. Paulraj and Dr. N. Balasundaram (Jan 2017), Experimental Studies on Strength and Scc Characteristics of Basalt FiberReinforced Concrete, Volume 8, Issue 1, pp. 704–711.

[9] Aly T Sanjayan G and Collins F (2008), "Effect of polypropylene fibers on shrinkage and cracking of concretes".

[10] Eswari S, Raghunath P and Suguna K (2008), "Ductility Performance of Hybrid Fiber Reinforced Concrete".

[11] C. Barris, L. Torres, A. Turon, M. Baena and A. Catalan, An Experimental Study of the Flexural Behavior of Gfrp Rc Beams and Comparison With Prediction Models.

[12] M. A. Adam, M. Said, A. A. Mahmoud and A. S. Shanour, "Analytical and Experimental Flexural Behavior of Concrete Beam Reinforced with Glass Fiber Reinforced Polymer Rebar", Int. J. Construct. Build.

[13] V.P.V. Ramanaa, T. Kanta, S.E. Mortonb, P.K. Duttac, A. Mukherjeea, Y.M. Desaia "Behavior Of CFRPC Strengthened Reinforced Concrete Beams With Varying Degrees Of Strengthening".

[14] G. Jeenu, R. Reji, and V. Syam Prakash, "Flexural Behavior of Hybrid Fibre Reinforced Self Compacting Concrete", Proceedings of the International Conference on Our World in Concrete & Structures.

[15] Shukla M (Oct. 2011), "Behavior of Reinforced Concrete Beams with Steel Fibers under Flexural Loading", International Journal of Earth Sciences and Engineering, Vol. 4, pp. 843-846.

[16] V. Gribniak et al., Comparative Analysis of Deformations and Tension-Stiffening in Concrete Beams Reinforced with GFRP or Steel Bars and Fibers, Int. J. Composite, Part B, 50(13), 158-170 (2013).

[17] ACI Committee 440, Guide for the Design and Construction of Concrete Reinforced with FRP Bars (ACI 440.1R-06), Farmington Hills, Michigan (USA): American Concrete Institute (2006).

[18] R. V. Balendran, W. E. Tang, H. Y. Leung and A. Nadeem, Flexural Behaviour of Sand Coated Glass Fibre Reinforced Polymer (GFRP) Bars In Concrete, Proceedings of 29th Conference on Our World In Concrete & Structures: 25-26 August, Singapore, 203-212 (2004).

[19] A Review on Fiber Reinforced Concrete, Grija.S, Shanthini.D, Abinaya.S. *International Journal of Civil Engineering and Technology,* 7(6), 2016, pp.386–392.

[20] Esraa Kamal Jaafar, Experimental Study on Anchorage Bond in High Strength Reinforced Concrete Beams. *International Journal of Civil Engineering and Technology*, 8(1), 2017, pp. 63–71.